

**44.** The method of claim 43, wherein conservative estimates of hand and finger position offsets are maintained across a succession of proximity images even when hand contact identifications become unreliable, the method comprising the steps of:

computing the confidence in current contact identifications from the amount of information available for the identifications;

computing a weighted average of the individual hand contact velocities;

predicting a current hand and finger offset from the previous offset estimates and the weighted average velocity;

computing current hand and finger offsets from current contact identities and measured contact locations;

setting the currently measured hand and finger offsets to zero if the hand has no contacts in the current image; and

updating the hand and finger offset estimates to the as weighted average of the predicted offsets and currently measured offsets, wherein the relative weighting given to the measured offsets increases in proportion to the confidence level in the current identifications.

**45.** The method of claim 44, wherein a hand sliding to the opposite side of the surface eliminates the estimated position of a lifted hand by imposing a minimum separation between the estimated hand positions, and permitting the hand with a highest identification confidence override the estimated position of the other hand.

**46.** A method for establishing identities of hand contacts on a multi-touch surface using relative contact positions and features, the method comprising the steps of:

defining a template of hand part attractor points on the surface, the attractor points for each hand roughly forming a ring;

computing a matrix of distances from each surface contact to each attractor point;

weighting the distances between each surface contact and each attractor point according to how closely measured contact features such as proximity to a surface, shape, size, eccentricity, orientation, distance to nearest neighbor contact, and velocity match features typical of the hand part the attractor point represents;

finding a one-to-one mapping of the surface contacts to the attractor points that minimizes a sum of distances between each surface contact and its corresponding attractor point; and

recognizing particular hand configurations from the number and features of surface contacts assigned to particular subsets of the attractor points.

**47.** The method of claim 46, wherein an attractor point which is unassigned to a real surface contact because there are less surface contacts than attractor points contributes nothing to the sum of distances.

**48.** The method of claim 46, wherein the distance metric used for computing the distance from a surface contact to an attractor point is the squared Euclidean distance.

**49.** The method of claim 46, wherein the attractor point positions correspond to the positions of hand part surface contacts measured when each hand is in a neutral posture.

**50.** The method of claim 46, wherein forepalm contacts of the hands are recognized by adding attractor points near the center of the attractor point ring of each hand, and weighting the distances to the forepalm attractor points so that contacts are assigned to the forepalm attractor points only if the hand produces enough contacts to nearly fill the attractor ring.

**51.** The method of claim 46, wherein the portion of an attractor template corresponding to parts of a particular hand is translated to remain centered on the last estimated position of that hand.

**52.** The method of claim 46, wherein a portion of the attractor points template corresponding to parts of a particular hand is rotated and/or scaled to match a previous estimated orientation and size of that particular hand.

**53.** The method of claim 46, wherein all of the surface contacts to be assigned are assumed to have come from the same hand and all of the attractor points represent parts of one hand.

**54.** The method of claim 46, wherein an additional hand identification means restricts assignment of the surface contacts to those attractor points which the hand identification means assigned to a particular hand.

**55.** The method of claim 46, wherein the measured distance from a contact to a thumb attractor point on a given hand is weighted so as to encourage assignment to the thumb attractor when the total contact proximity is greater than that of a typical fingertip but less than that of a typical palm heel.

**56.** The method of claim 46, wherein the measured distance from a contact to a thumb or inner palm heel attractor point on a given hand is weighted so as to encourage assignment to that attractor when the contact orientation approaches the expected slant of a thumb or inner palm heel on the given hand.

**57.** The method of claim 46, wherein the measured distance from a contact to a palm heel attractor point on a given hand is weighted so as to encourage assignment to the palm heel attractor when the measured contact width or ratio of total proximity to eccentricity exceeds that of a typical finger.

**58.** The method of claim 46, wherein additional contact and inter-contact features are incorporated during a verification step, the verification step comprising shifting assignments found in the attractor points minimization step to make the assignments more consistent with additional feature tests used in the verification step.

**59.** The method of claim 58, wherein the verification step checks horizontal position coordinates of contacts assigned to attractor points corresponding to fingertips to ensure they are in increasing order for right hand fingertips and in decreasing order for left hand fingertips.

**60.** The method of claim 58, wherein the verification step includes a thumb verification step comprising the following sub-steps:

finding an innermost finger contact by searching for a contact assigned to a filled attractor point corresponding to an innermost finger;

computing a thumb factor as a function of the innermost finger contact relative to other finger contacts;

shifting the innermost finger contact to a thumb attractor point if the innermost finger contact is not already